Fermi GBM and LAT Solar Flare X Ray and γ Ray Observations

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Introduction

Our Fermi GI program makes GBM (8 keV - 30 MeV) and LAT (10 MeV - 10 GeV) solar flare data and our IDL analysis software tools readily available to the international solar physics community. The observations provide information on the highest energy flare-accelerated electrons and ions. The quicklook displays and spectral analysis tools are all based on familiar RHESSI mission software.
We are creating the following online products:

- IDL tools for joint spectral and time series analysis using OSPEX in SolarSoftWare.
- Solar flare list including which GBM detector observed the flare, as well as the usual flare parameters
- Quicklook plots of GBM light curves for each orbit
- Event FITS files will be made for LAT solar flare data.
- GBM solar flare data and the corresponding response files will be transparently downloaded to the local system for events selected by software from the current GBM flare catalog.

We identify solar hard x-ray flares in the GBM data stream that correspond to a GOES C1-class or stronger for inclusion in our flare catalog. The full GBM data stream is available for download through the FERMI public data archive and is accessible on as-needed basis through an interface in OSPEX.
For gamma-ray flares we will prepare data files of the LAT data that can be analyzed with OSPEX including parameterized high-energy emission models.

On-line at hesperia.gsfc.nasa.gov/fermi_solar

- GBM Flare Catalog – Starts 8-aug-2008
- Solar flare list including which detector observed the flare, as well as the usual flare parameters. See extract below
- Daily GBM lightcurve plots showing >8 keV NaI rates and >300 keV BGO rates together with GOES XRS. Note that the NaI lightcurves are composite rates of the three most sunward detectors less the rates from the three most antisunward detectors. See Fig 1
- Quick look plots of GBM light curves for each orbit

Fermi GBM Flare List Subset (generated 21-May-2010 18:14)

Total # flares: 72 Time range: 2-Jan-2010 14:15:23.600 - 8-May-2010 20:16:18.057 Selected

Flare	Start time	Peak	End	Dur	Peak	Total	Sunward	Trigger	RHESSI
				s	c/s	Counts	Detectors		Flare #
100119_2032	19-Jan-2010 20:32:20	20:33:42	21:06:07	2028	72673	6961514	n5 n4 n2 n1		10011938
100119_2225	19-Jan-2010 22:25:27	22:31:52	22:43:46	1099	30752	6822395	n5 n1 n3 n0	SFLARE10011993	10011941
100120_0012	20-Jan-2010 00:12:10	00:19:00	00:29:51	1061	10846	993873	n3 n1 n0 n5		10012001
100501_0136	1-May-2010 01:36:14	01:38:29	01:44:24	490	42517	5809795	n3 n1 n0 n5	SFLARE10050106	
100505_0716	5-May-2010 07:16:21	07:16:25	07:17:59	98	802	9529	n5 n1 n3 n4		
100505_1154	5-May-2010 11:54:20	11:54:28	11:56:59	160	4250	97456	n5 n4 n2 n1		10050514
100505_1715	5-May-2010 17:15:52	17:18:06	17:29:40	828	185420	18787468	n3 n1 n0 n5		10050524
100507_0735	7-May-2010 07:35:15	07:35:44	07:44:57	582	1987	142374	n3 n1 n0 n5		10050714
100508_1145	8-May-2010 11:45:17	11:49:19	11:52:48	451	3839	140166	n5 n1 n3 n0		10050820
100508_2008	8-May-2010 20:08:27	20:09:31	20:16:18	471	8915	934928	n5 n1 n3 n0	UNRELOC1005088	10050836

Notes:
Peak time, peak rate, and total counts are listed for the 12-25 keV energy range.
Sunward Detectors are the four most sunward detectors at the peak of the flare (in the 12-25 kev band).
If this flare was detected as a trigger by the Fermi group, the Fermi trigger designation is listed.
RHESSI flare number is provided if it overlapped the GBM flare. If more than one overlapped, the one whose peak time is closest to the GBM peak time is listed.

Fermi Gamma Ray Burst Monitor (GBM)

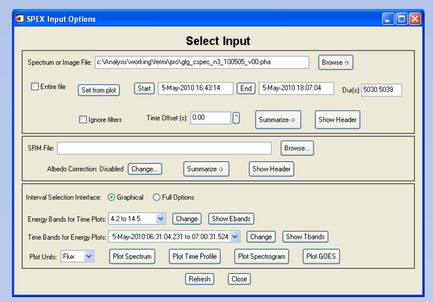
The Gamma Ray Burst Monitor on Fermi consists of 12 NaI scintillators detectors sensitive to X-rays from ~8 keV to 2 MeV. They are positioned to respond to gamma ray bursts from all over the sky. During the daylight portion of the Fermi orbit normally 3-4 detectors see the Sun with good sensitive area. The spacecraft is slewing through the orbit as they are mapping out cosmic sources for the very high-energy Large Area Telescope (10 MeV to 100 GeV) so some attention must be paid to the changing Sun-detector angles through flares that can last for 1000s of seconds. We see the changing cosines of the angles in Figure 2. The cosine for detectors 3 and 1 are virtually identical at this time and only 3 shows on the plot.

SSW and OSPEX Support for Fermi

OSPEX is a spectral analysis and lightcurve display object package available through SSW that runs under IDL. It has been modified to fully support the analysis of GBM solar flare data in a user-friendly manner as is done for RHESSI.

The OSPEX spectral analysis package has been modified to –

- Find and access solar flares through the local copy of the GBM flare catalog (via SSW). See the Select Input gui below.
- Download, if necessary, and read the GBM data and response files. Select time of interest from daily data. See the Select Time gui below.
- Analyze and fit the GBM spectra using familiar OSPEX tools as in Figure 3. RHESSI spectral fits post-anneal agree well with GBM fits.
- Use new nuclear-line and pion decay gamma-ray templates with high-energy flare data from GBM and LAT.



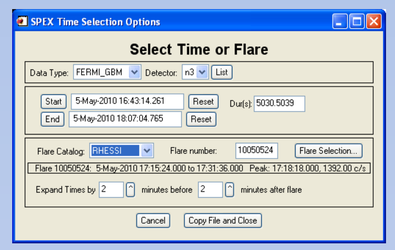


Figure 1

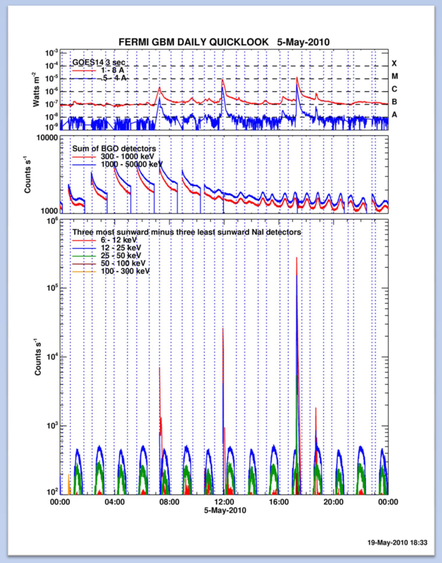


Figure 2

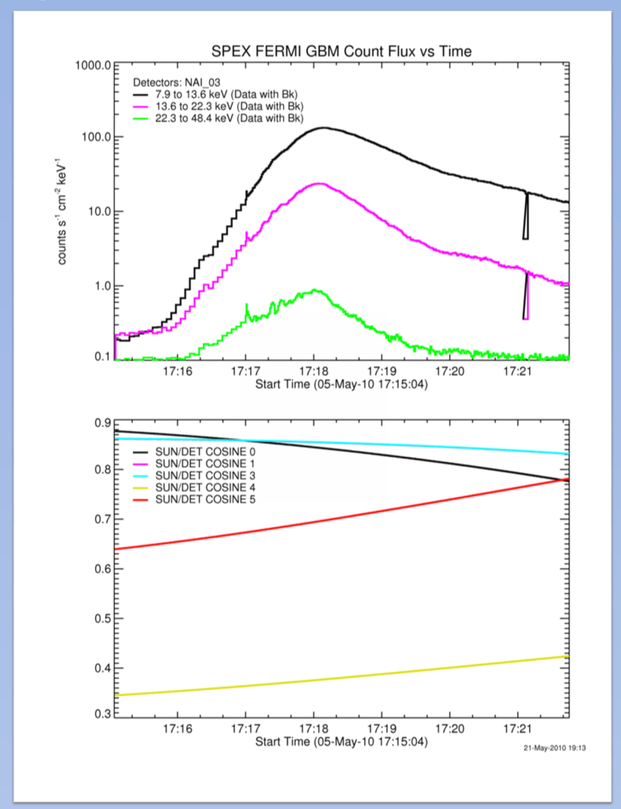
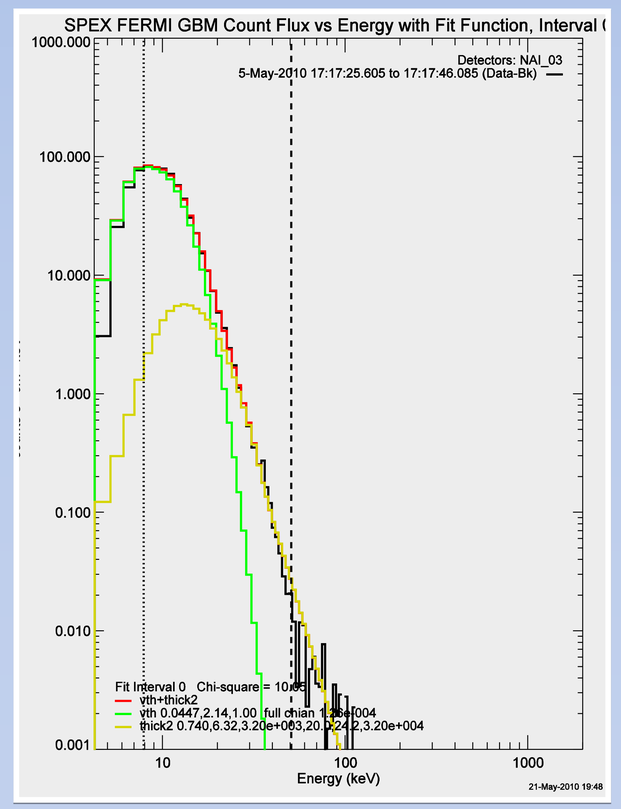


Figure 3



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